

Hyundai Steel's Challenge toward “Automotive Steel Specialized Steelworks”



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R&D Center, Hyundai Steel Company

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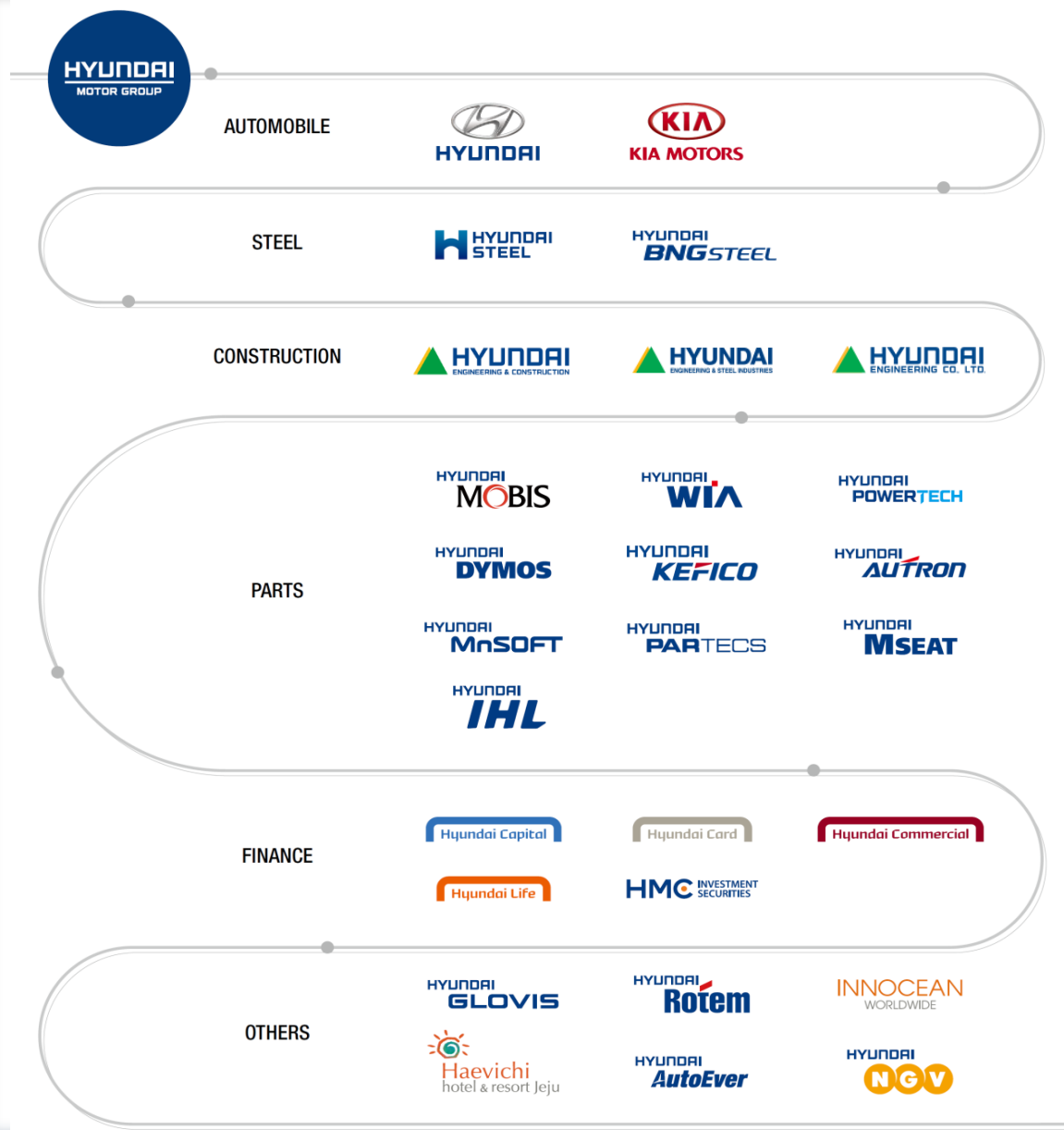
| **Hyundai Steel Overview**

| History of Challenge

| Toward “Automotive steel specialized steelworks”

| Vision Forward

Hyundai Steel at a Glance – Hyundai Motor Group



6 Business Groups

- Automobile
- **Steel**
- Construction
- Parts (Machinery)
- Logistics
- Finance

Volume

- Sales of USD 270billion
- 50 Affiliates
- 150,000 Employees

Applications

- Automotive
- Building
- Shipbuilding
- Onshore Energy
- Offshore Energy
- Wind Power
- Pipeline

History of Growth

1953

Established as
Korean Heavy
Industry Corporation

1978

Incorporated into
Hyundai Group

**Foundation
&
Expansion**

2001

Incorporated into
Hyundai Motor
Group

**Growth as
a Comprehensive
Steelmaker**

2006

Renamed to Hyundai
Steel Company

Ground Breaking
Ceremony for
integrated steelworks

2005

Foundation
of R&D center

2004

Ceremony marking the
acquisition and merger of
Hanbo steel's Dangjin
plant

2010

Operation of blast
furnace # 1 & 2

2013

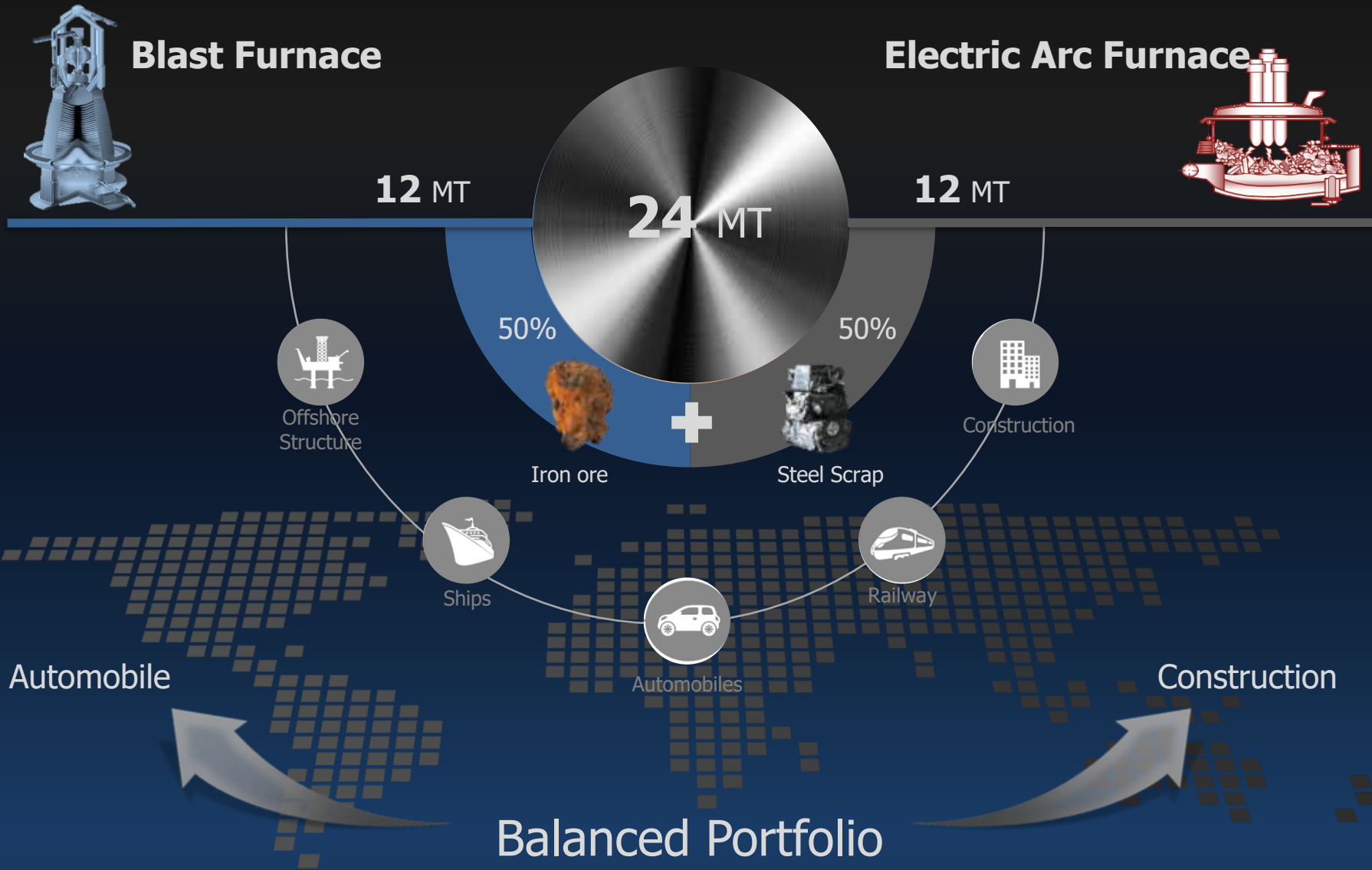
Operation of
blast furnace # 3

2014

Merged with
Hyundai Hysco

**To become
a Global
Steelmaker**

Business Structure



Domestic Production Sites

Incheon(4.7 mil. ton)

EAFs



H-beams, stainless steel

Dangjin(15.6 mil. ton)

BFs, EAFs




Hot/Cold-rolled coils, Heavy plates, Rebar

Yesan



Hot Stamping

Suncheon



Forging(0.3 mil. ton)


Suncheon



Cold rolled(2.0mil. ton)

Pohang (3.4 mil. ton)

EAFs



H-beams, rebar, rails

From Blast Furnace	from Electric Arc Furnace
Hot Rolled Steel 	Rolled Shape 
Cold Rolled Steel 	Steel Reinforcement 
Heavy Plate 	Special Steel 

Ulsan(1.2 mil. ton)



Pipes



Global Operations

- Manufacturing plant
- Steel Service Center



* Sales Branch excluded

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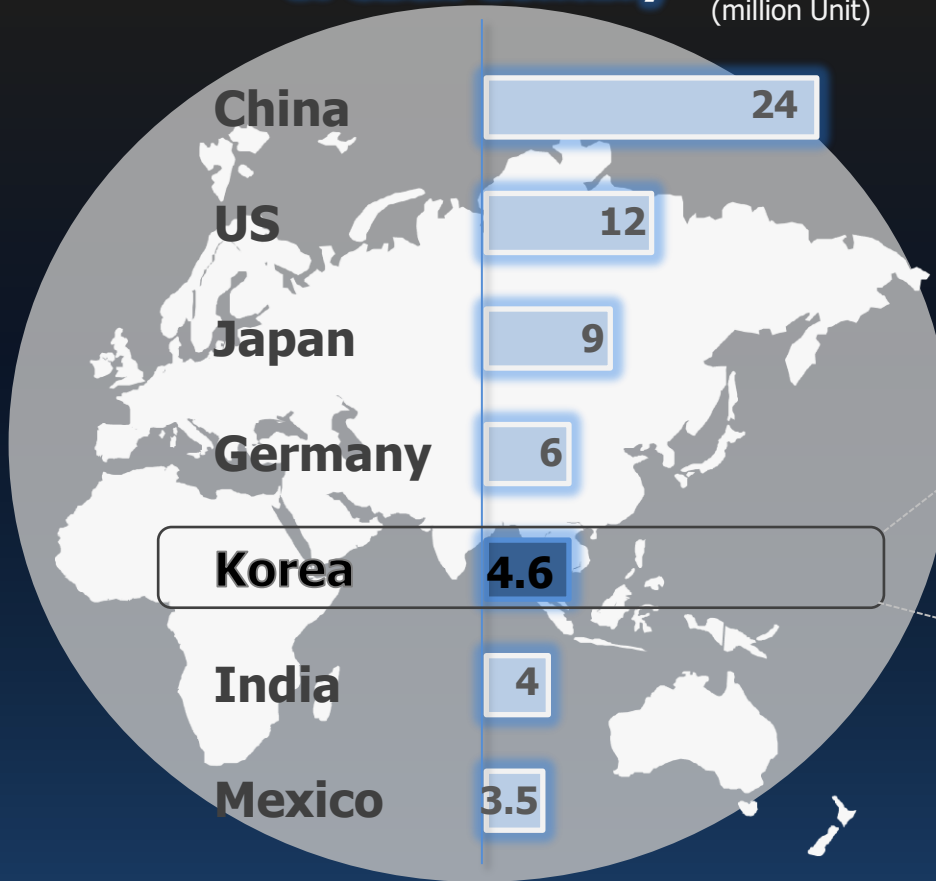
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| Vision Forward

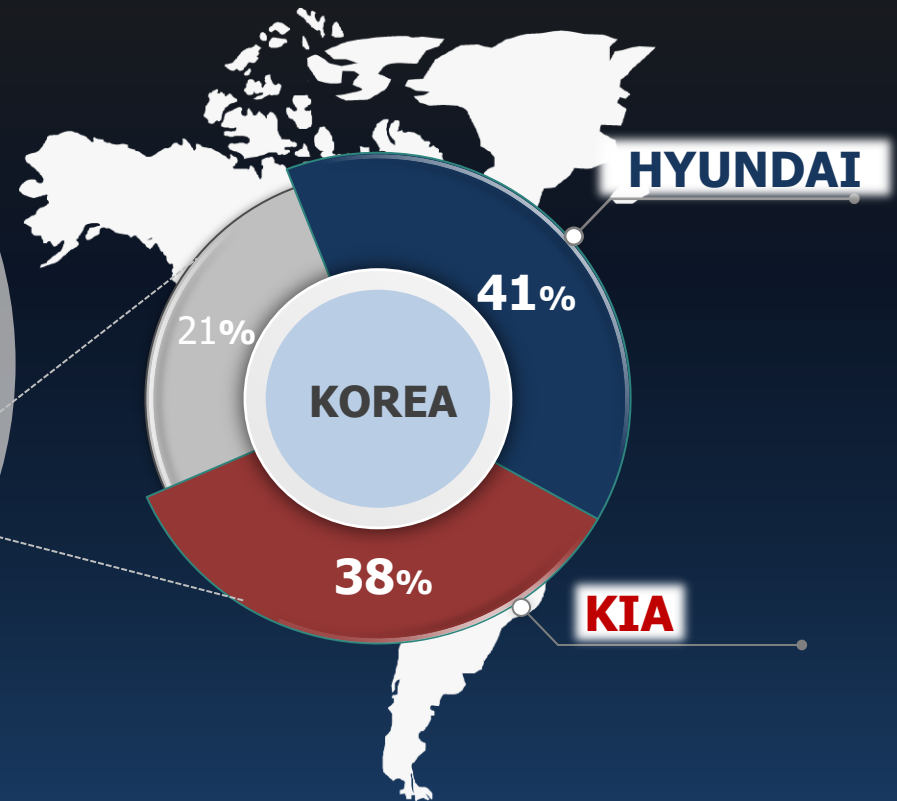
Status of Korean Automotive Industry

**Domestic Production
of each Country**

(million Unit)



**Global Production of HKMC :
820million unit**



Steel Industry and National Economy

Steel Industry



Steel industry contribute to the economic growth of our country by stable supply of high-quality materials to downstream industries such as automotive, shipbuilding, construction

Support for National Industry

Supplying competitive materials for Automotive, Shipbuilding, Construction Industry, etc.

1,082kg

Steel consumption per capita

Capital Investment

Steel Industry needs huge capital investment

12.5%

Steel/
manufacturing

Employment Effect

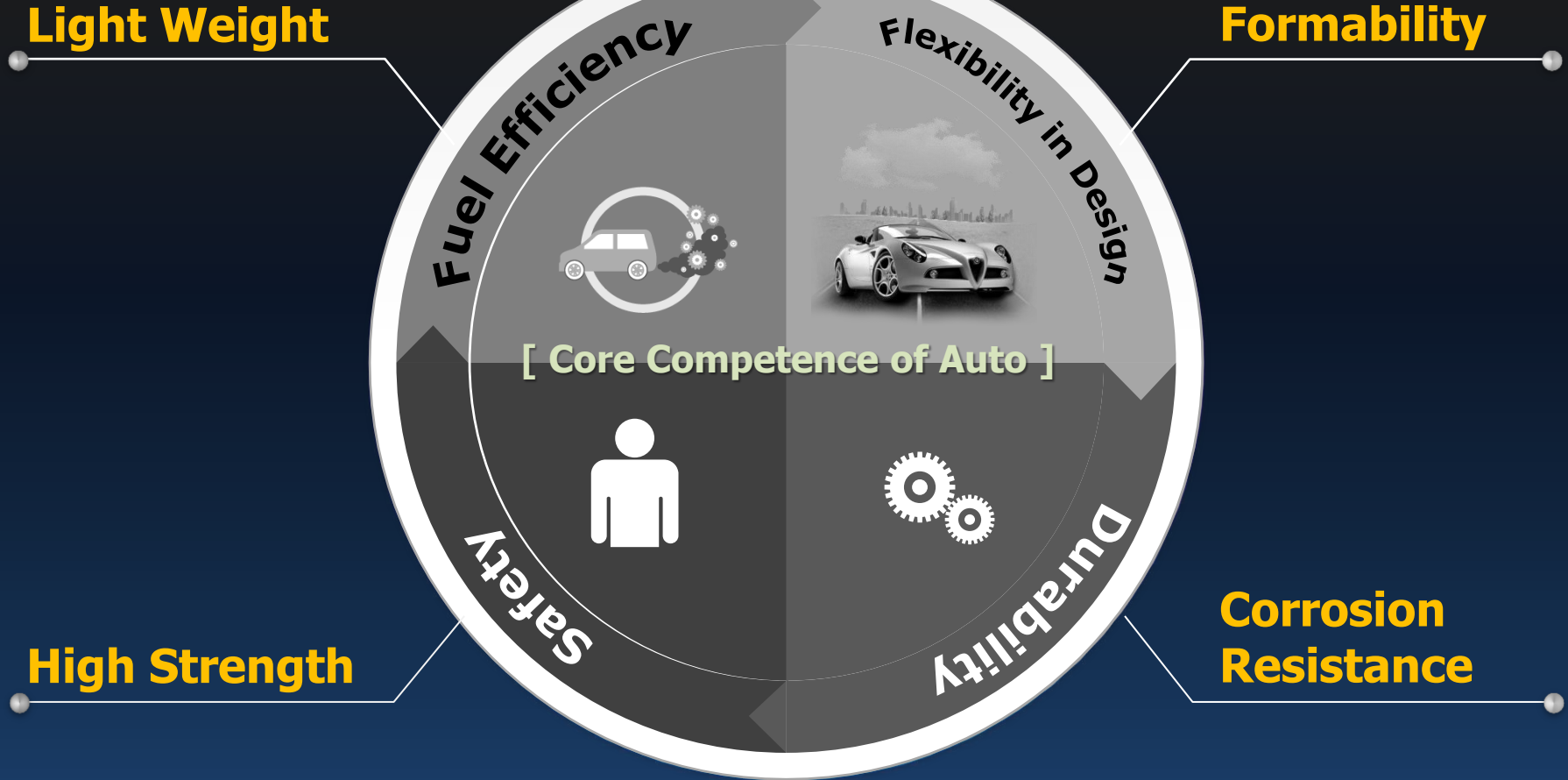
Employment volume : about 100 thousand people

2.7%

Steel/
manufacturing

Steel supports Automotive Industry in Technological Side

[Progress in Steel Performance]



Automotive Steel, Key Competency of Steel Makers

Market Share of Global Top 7
in automotive steel

65%

Automotive steel is technology-intensive, so there are a few players.



* Production Capacity Portion

Average Operating Profit
of Asian Steel maker

12%

Automotive steel is very profitable business, so the key players focus on it.



* 20%

Korean Integrated Steel Makers



32%

Japanese Integrated Steel Makers

* Automotive steel portion of steel makers' total shipment

Launching of Integrated Steel Mill Project

Near to major customers

Located mid-western part of Korea



Kia (Hwaseong)
Capacity 600,000 Units



Hyundai Steel
(Dangjin)



Hyundai (Asan)
Capacity 300,000 Units

West Coast Express Way

Completion of the Project

[Before 2006]



October 27, 2006

Dangjin integrated steel mill
project
ground-breaking ceremony

[After 2013]



Sites Areas : 8.82 million m² (2,179 acres)

Capacity : 12 million tons (3 Blast Furnaces)



Blast Furnace Blow-in

- # 1 : January 2010
- # 2 : November 2010
- # 3 : September 2013

Economic Effects of the Project

Job Creation

201

thousand people

Investment

18.2

billion US\$

Value Added Inducement

9.34

billion US\$

*1US\$=1,160KRW

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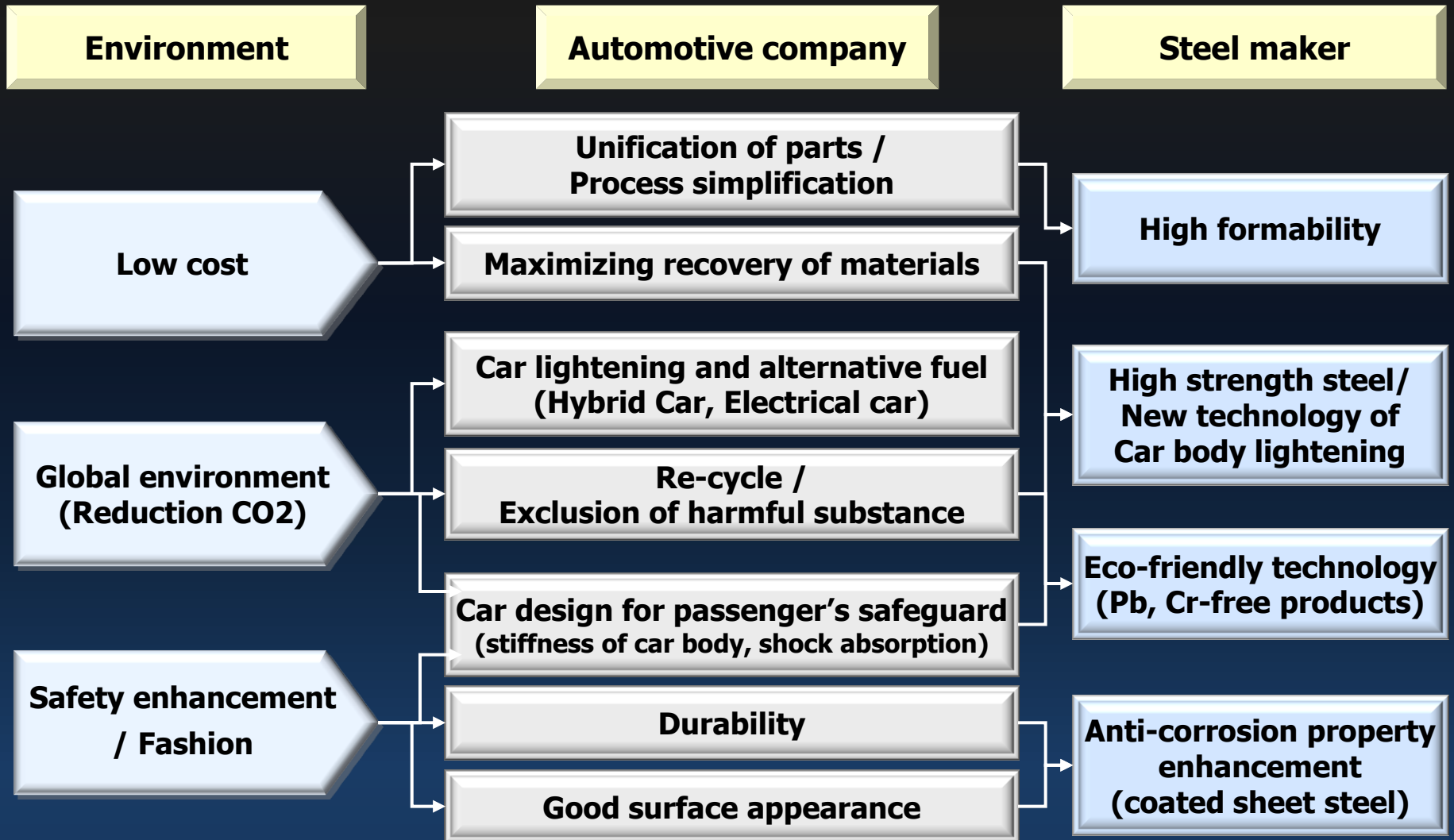
| **Toward “Automotive steel specialized steelworks”**

- Trend of Automotive steel
- Development of automotive steel
- Light-weight technologies (for part manufacturing)
- Application technologies

| Vision Forward

Trends of Automotive steel

Needs of automotive market and counter measurement of steel maker



Automotive Steel : High Strengthening & Diversification

1993

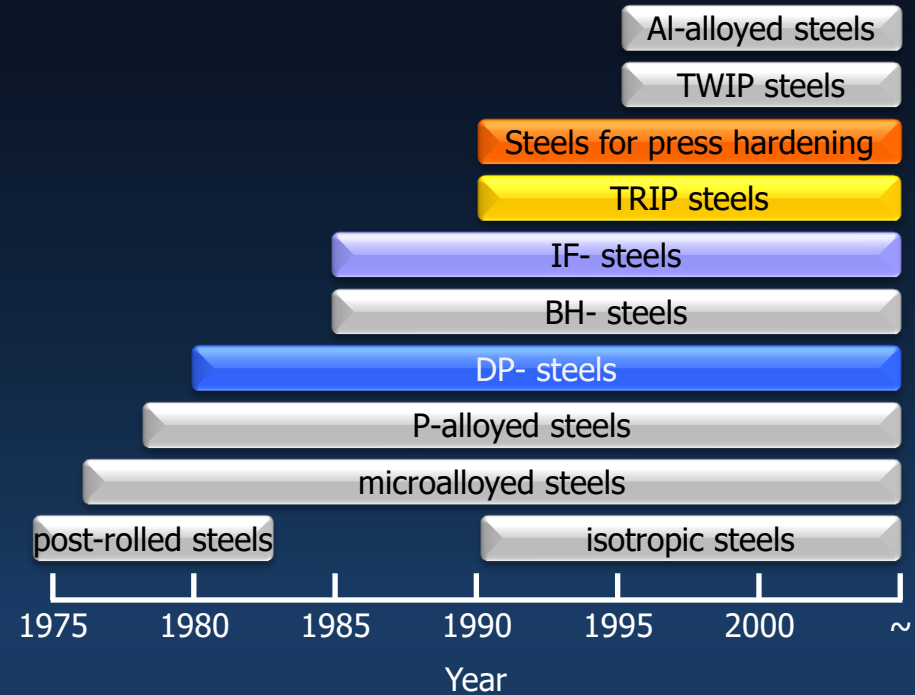
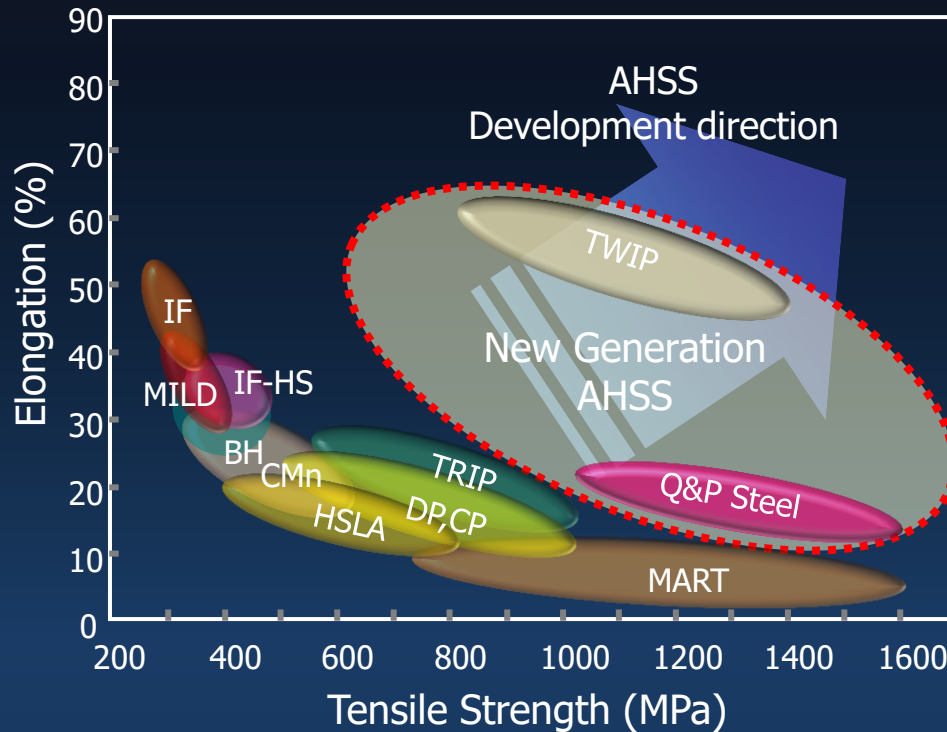
6 Steel Grade

2004

37 Steel Grade

2010~

Over 100 Steel Grade

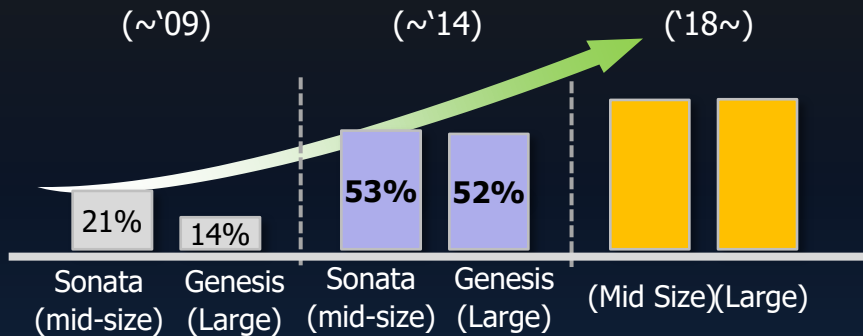


Application Trend of Car-body Material

Mass Production Car : High Strength Steel

Portion of High Strength Steel

● HKMC



● Others

Portion of TS 60K↑ steel	Audi A3	Honda Civic	BMW 3series	Ford Fusion	VW Golf 7G
	35.3 %	49 %	16.0 %	30.9 %	37.0 %

Adoption of Hot-stamping increases

- VW Golf 7G : 5% → 21%
- HKMC Sonata : 3% → 12%

Luxury Car : Light-weight material

Aluminum sheet



Tesla Model S ('12)

- ▶ **Best selling Luxury Sedan In US**
(2013 , US\$70,000, 22.000units)
- ▶ **Max. driving range : 480km**
(usual EV 120km)



Ford F150 ('15)

- ▶ **Al body** (317kg↓)
- ▶ **Best selling Pick-up in North America** (700,000~800,000 units/year)

CFRP (Carbon Fiber Reinforced Plastics)



BMW i3 ('13)

- ▶ **First mass produced car with CFRP**



BMW i8 ('14)

- ▶ **CFRP portion 23%**
- ▶ **Driving range/Max. Speed /0-100 times**
: 130km/150kph/7.2s

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Development of Automotive Steel in Hyundai Steel

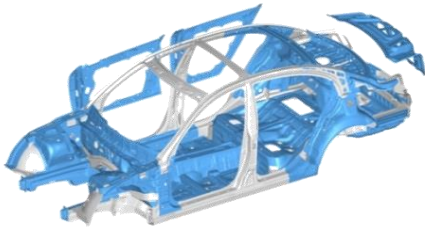
Developed 99.6% of Automotive Steel used by HKMC

2010

49grades

Inner Panel

High Formability
60K



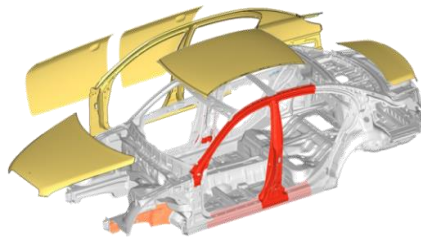
Floor

2011

22grades

Outer Panel

80K high strength
150K hot stamping



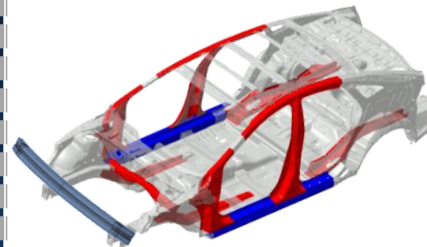
Door/Hood

2012~14

17grades

Ultra High
Strength Steel

100/120k

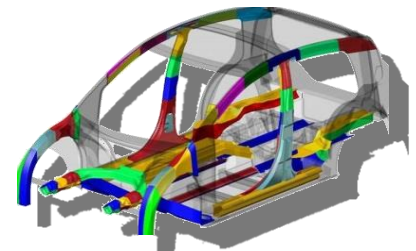


Center Pillar

2015~

Newly developed
grades

Next-generation
Automotive steel



Light Weight/Anti-corrosive

Manufacturing Process & Product Mix (Integrated Steel Mill)

Unit : thousand tons

Iron Making

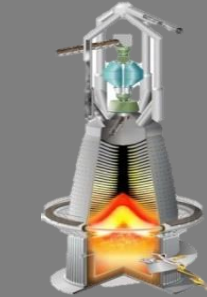
Iron ore
19,000



Cokes
8,700



Others
3,600



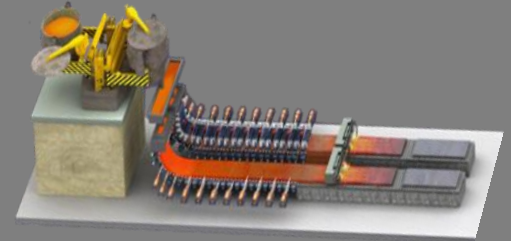
Molten Iron
12,000

Steel Making



Molten Steel
12,800

Continuous casting



Slab
12,500

Product

Hot Rolled Coil



8,850

Cold Rolled Coil



6,030

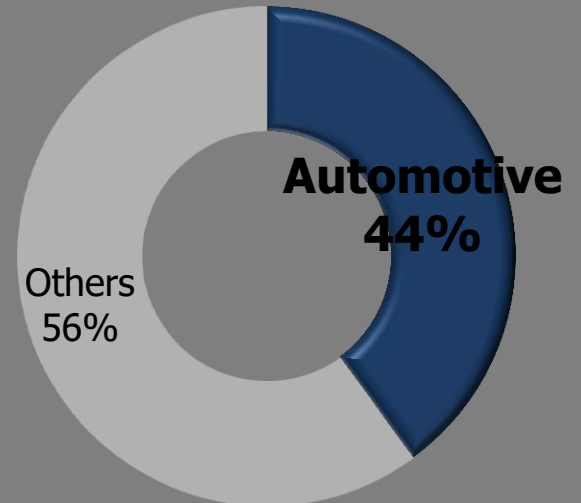
Heavy plate



2,500

Total Products
11,180

Product Mix



R&D Process for Automotive Steel

Vacuum melting



- vacuum melting according to alloy design

Hot rolling



- hot rolling of reheated Ingot
- main factor : reheating temp.
coiling temp

Cold Rolling



- cold rolling of Hot coil to get target thickness
- main factor : rolling force

Analysis

Composition	OES, C/S, N/O
Formability	LDR, LDH, FLD
Coating layer/ Surface	AES, XRF Roughness measurement
Microstructure	XRD,EBSD,TEM, Dilatometer

Coating



- simulation of coating
- main factor : atmosphere, temp.

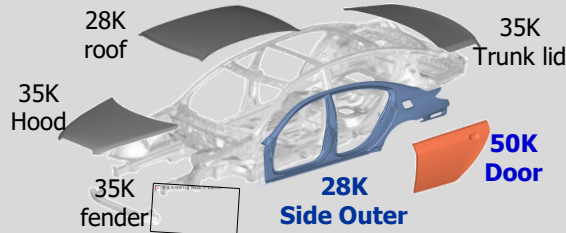
Continuous Annealing



- Annealing of F/H
- main factor : annealing temp,
cooling rate

Hyundai Steel : Directions for Automotive steel

Outer panel



High Strength
(Door)

340MPa
BH

High Strength
(side Outer)

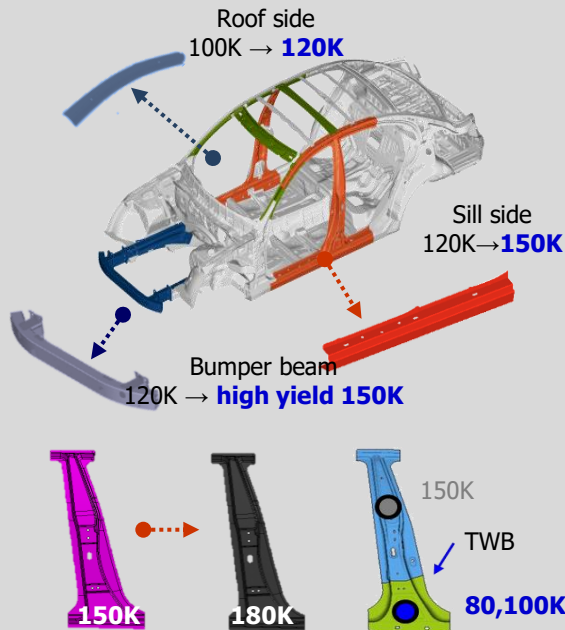
Mild

Dent
resistance

490DP Outer

**High Strength
Outer**

Frame structure



High Strength

340~440MPa

**+
High
formability**
(ultra high strength
CRC)

980MPa

Car -body
lightening
Safety
performance

780MPa AMP

1180MPa

1180MPa

1470MPa

High Strength

**+
High
formability**
(Heat treatment)

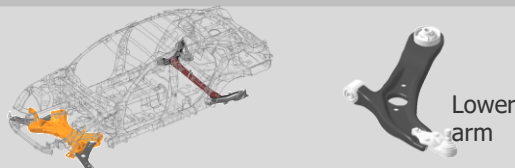
1470MPa
Hot stamping

Light weight
Safety (Crash)

**1.8 (2.0) GPa
Hot stamping**

**TWB +
Hot stamping**

Chassis



**High Strength +
burring**

540/590MPa
PO

Anti
corrosive

**540/590/780MPa
Coated HRC**

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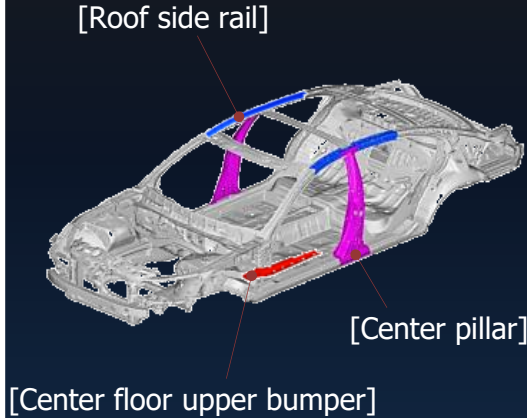

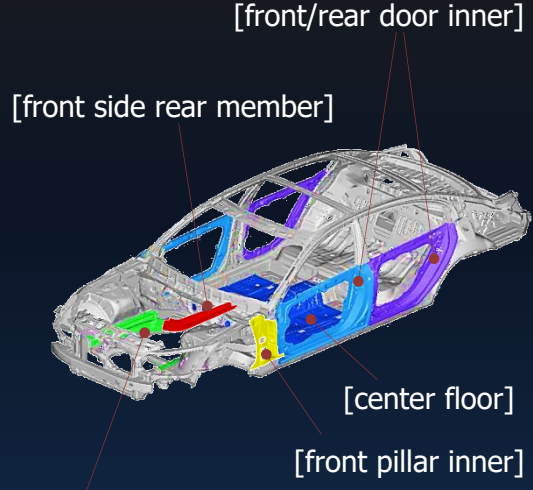
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New technology for Parts – Application & Manufacturing line

	Hot Stamping	Hydro Forming	Tailor Welded Blanks
Parts	 <p>[Roof side rail]</p> <p>[Center pillar]</p> <p>[Center floor upper bumper]</p>	 <p>[Front sub frame]</p> <p>[rear axle frame]</p> <p>[trailing arm]</p> <p>[frame side member]</p>	 <p>[front/rear door inner]</p> <p>[front side rear member]</p> <p>[center floor]</p> <p>[front pillar inner]</p> <p>[front side member]</p>
Capa.	<p>17 Line (Ulsan 2, Yesan 10, Overseas 5)</p> <p>38million unit/year</p>	<p>3 Line (Ulsan 3)</p> <p>2.1million unit/year</p>	<p>23 Line (Suncheon 6, Ulsan 4, Yesan 2, Overseas 11)</p> <p>25million unit/year</p>

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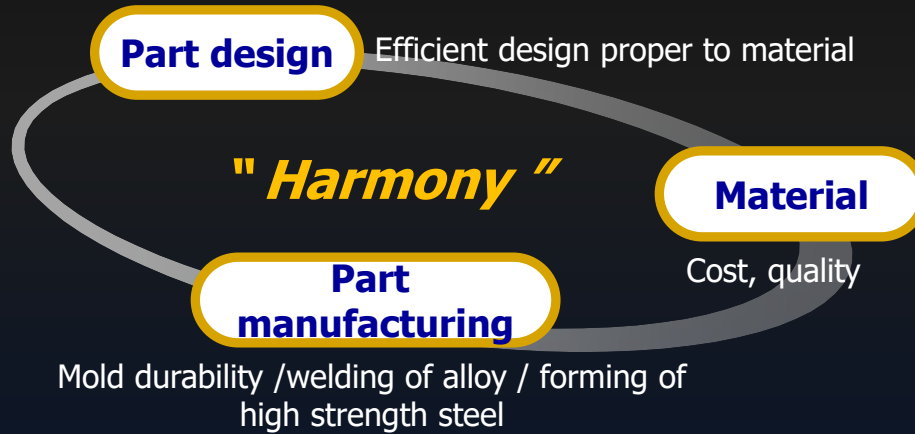
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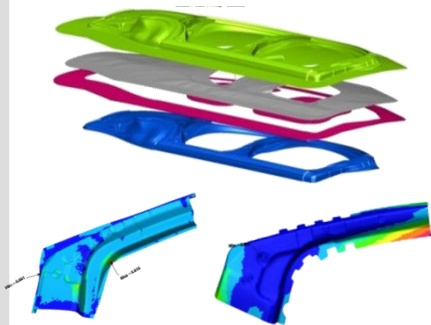
Application Engineering : Concept and Scope



Convergence
Of
Technology



Forming / simulation



Welding



Anti-corrosion



Collaboration



EVI (Early Vendor Involvement)

Customer & Social Needs

Safety, Convenience, Cost

Eco-Friendly, Recycling

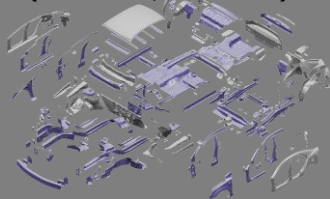


New Carbody

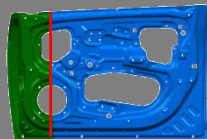


Proposal of Optimum solution

(material, Process)



< Optimum Material proposal >



Hot Stamping

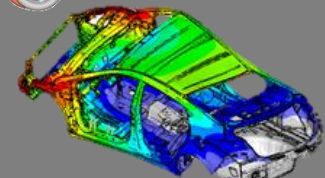
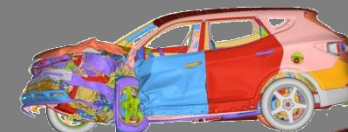
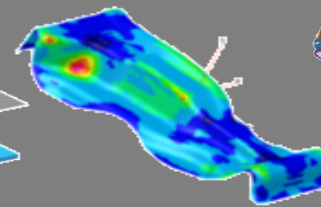
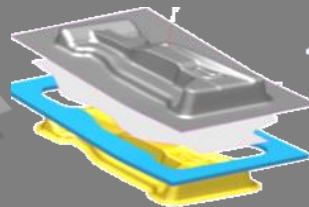
TWB

< Light-weight technology >

EVI Activities

Provide steel based total solution for light weight car body

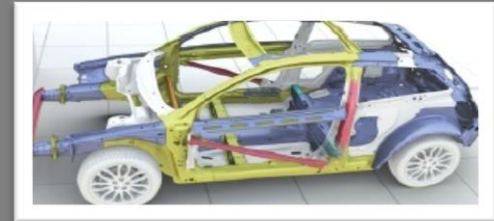
CAE Analysis (Design & Structure)



< Stamping analysis >

< Crash and stiffness analysis >





Optimized autobody



Weight vs Cost vs Performance

Status of HSC's Application Engineering



	Main Building	Rolling Lab	Ironmaking Lab	Total solution Center
Role	<ul style="list-style-type: none"> ○ Analysis ○ KOLAS 	<ul style="list-style-type: none"> ○ Development New grades ○ Car teardown 	<ul style="list-style-type: none"> ○ Simulation of iron making ○ Raw mat'l quality control 	<ul style="list-style-type: none"> ○ Application Engineering ○ Environment tech.
Equip ment	<ul style="list-style-type: none"> ○ TEM, SEM... 	<ul style="list-style-type: none"> ○ HR/CR simulator 	<ul style="list-style-type: none"> ○ Cokes oven simulator 	<ul style="list-style-type: none"> ○ 1,000t Servo Press 

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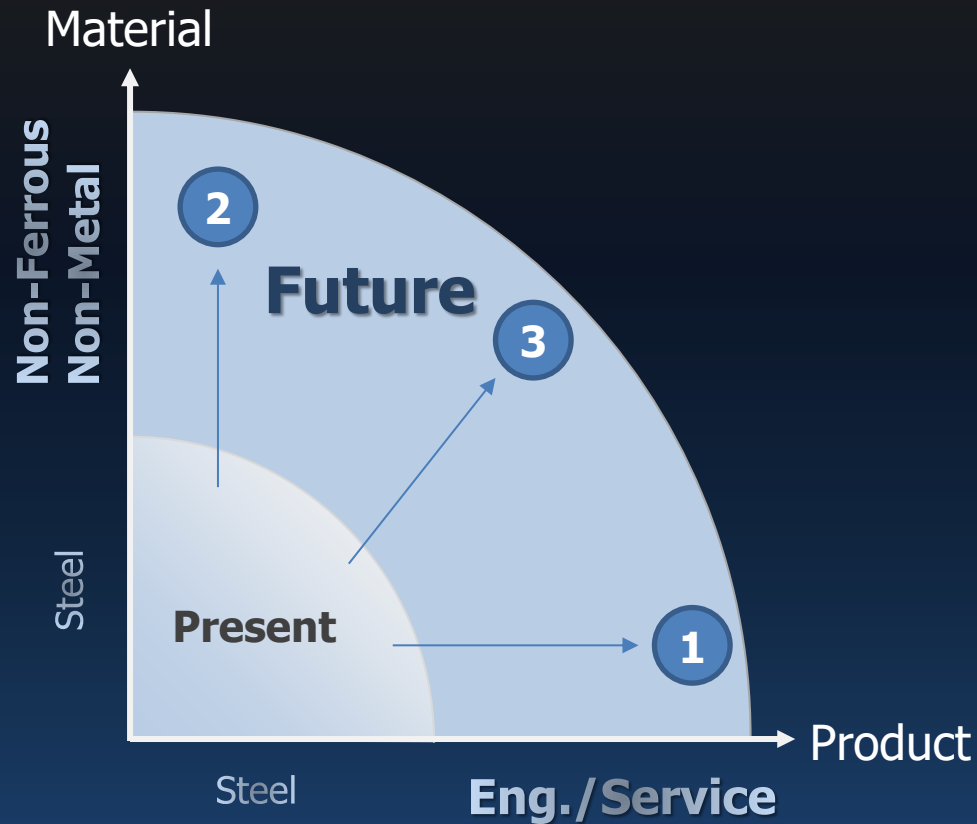
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What is next in HSC's Automotive steel

New Vision : "Engineering Future beyond Steel"
Providing new Value beyond Steel

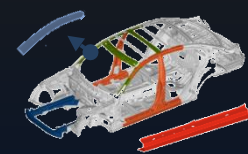


Up to now : Fast Follower

Develop all of the automotive steel (88 grades)

Body (ULC steel)

Frame (AHSS)



From now on : **First Mover**

Next generation Steel

High Strength
+
High formability

**Convergence
of
Technology**

Automotive steel
leader

Total sol'n

Application Eng
Material Tech.
(non ferrous , non
metal)